THE ARTIFICIAL FEEDING OF INFANTS DURING THE FIRST YEAR OF LIFE.

A Thesis for the degree of M.D.

by

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The low birth-rate and high infantile mortality have very rightly aroused both public and professional attention to a more serious study of those medico-sociological conditions which are inimical to racial evolution, and particularly to the advancement of our own people among the nations of the earth. The extreme frequency of disorders of nutrition amongst infants and children, and the enormous mortality resulting therefrom, are the writer's sole excuses for submitting so very ordinary a subject for consideration. He holds the strong conviction that the more frequent the disease, and the more fatal its results, the greater the claim it has upon our attention as physicians. In few subjects have such rapid advances been made as in the pathology of these affections. While sanitary improvement has produced an almost continuous decline of the general death-rate, there has been no corresponding reduction in infantile mortality. From statistical studies it appears that the infantile mortality of the country as a whole is stationary. This means that the infant population has not shared in the general improvement at other ages. But poor comfort is to be found in the fact that many other countries, including Germany, Austria, Italy and Spain, are considerably worse in this respect, while/

while France, Switzerland, Belgium and Holland are as bad. In a leading article on "Infant Mortality" the "Berliner Tageblatt" (Jan. 1906) says :-

"The exceptionally high rate of mortality among infants in Germany has, for a long time, been a subject for serious concern. Doctors, political economists, officials of the State and of the municipalities are all working most zealously at the problem of the reduction of the death-rate amongst infants. This matter is a most serious one for the future of our nation, since statistical evidence shows that out of every 2,000,000 children born in Germany 400,000, one-fifth of the total die before attaining the age of twelve months. These are startling figures, and all the more so when we find that the death-rate amongst infants is much lower in France and even in Sweden, where the climatic conditions are less favourable. Further, it is a fact confirmed by the statistics that two-thirds of the deaths amongst infants are due to lack of proper nourishment."

The chief cause of infant mortality is not to be found in frailty of constitution. The plain truth is that the great majority of infants are killed by improper feeding. Artificial foods of one kind or another/

another have largely taken the place of the mother's milk, which is the natural nourishment of the infant. Many of these are prepared according to the strictest scientific principles, but at times they all prove failures. Mothers and nurses naturally look to their medical attendant for advice on feeding and clothing, and if he has nothing better to tell them than the old-fashioned formula - so much milk, so much water, etc. - then the time has arrived for him either to study the subject more or refuse to advise any longer. No doubt in some of these cases the mother is left too soon after her confinement, and the diet and management of her infant are entrusted to herself or a prejudiced uneducated nurse.

In regard to the mortality of infants, some interesting returns have been issued by various medical health officers. In Birmingham, which may be taken as an example of most large towns, over 3000 deaths per annum occur in infants under one year, as compared with 35 deaths at each yearly period between the ages of 5 and 25 years. The seasonal variations in this mortality are significant. They show that some cause is in operation during the third quarter among infants under one year producing 1,682 more deaths than during the/

the first quarter. The death-rate varied considerably from year to year in correspondence with the duration and amount of summer heat. The principal causes of death in order of importance were : (1) diarrhoea and enteritis; (2) debility and marasmus; (3) bronchitis, pneumonia and pleurisy; (4) premature birth; and (5) convulsions. The general infectious diseases, excluding epidemic diarrhoea, caused about five per cent of the total mortality of infants under one year. Diseases connected with the digestive system caused forty per cent and form the chief group for enquiry. Premature births and developmental diseases caused about fifteen per cent and tuberculous diseases five per cent. The only other important causes of death were the acute inflammatory diseases of the lungs - bronchitis and pneumonia - which together caused about fifteen per cent of the total. Nearly twenty-five per cent of all deaths were due to inflammatory conditions of the digestive system. Some interesting and instructive information was obtained from the health visitors in regard to the feeding of infants. Twelve hundred returns were made showing that among the artisan classes healthy babies under six months were fed as follows:-

breast/

breast fed entirely, 56.5 per cent; breast supplemented by bottle, 28.7 per cent: bottle only, 14.4 per cent. The deaths of 236 infants under six months from epidemic diarrhœa were similarly investigated with the following result :- breast fed entirely, ten per cent; breast and bottle fed, ten per cent; bottle fed only, eighty per cent. These figures agree with those of Liverpool.

The average death-rate of infants under one year per 1000 births, for the ten years 1893 - 1902, in England and Wales was 152, Scotland 127, Ireland 104; in 1903, England and Wales 132, Scotland ?, Ireland 96. England and Wales therefore compare unfavourably with Scotland, and still more so with Ireland. The alleged causes of these international differences may be, and probably are, in part climatic, in part sanitary, and in part social; social, on account of differences in respect of poverty, industrial occupation of mothers, artificial feeding of infants, and so on. The relatively wet summers of Scotland and Ireland, doubtless, lead to the prevention of much mortality from infantile diarrhœa which occurs in England. But it has been repeatedly shown that much of the death-rate from diarrhœa is preventible, even when external/

external conditions favour its occurrence. The cause proper lies in the care the mother exercises in regard to food and feeding.

Bacteriological investigators stepping in at this stage have since furnished a clue to the understanding of many of these conditions. First of all it is stated that the foetal intestine is sterile, but that a few hours after birth bacteria find an entrance to it. In a healthy nursing child two species of bacteria are said to be constantly found in the intestines. These are the Bacterium lactis aerogenes which inhabits the small intestine, and the Bacterium coli commune which lives in the colon and lower part of the ileum. In cases of summer diarhoea the intestinal contents are found to swarm with many species of bacteria, and some of these are very virulent. These organisms grow and multiply outside the body, and are abundantly disseminated when the temperature of the air is over 60°F. They grow best in milk. Unfortunately, milk at this period of the infant's life is the chief or only food; also, it is the very best cultivating medium in which these poisonous organisms can flourish.

It is thus easy to understand how the hand-fed infant so frequently falls a victim to summer diarrhoea, and/

and that this disease is almost confined to this period of life.

Human milk is a sterile fluid. Cow's milk is sterile only when obtained with aseptic precautions from the udder of a healthy cow by a trocar and cannula, but is usually acid when reaching the consumer, and is crowded with micro-organisms. The bacteria in milk may be roughly divided into three classes, according to their powers of resisting heat. (1) Non sporing bacteria. These include the cocci, the lactic acid, coli, and proteus groups. The members of these groups are easily killed by exposure to temperatures of 100°C., or by heating for a short time at a temperature ranging between 90° and 95°C. This latter temperature is reached when, in domestic parlance, articles of food are "brought to the boil". Pasteurisation - subjecting the milk to a temperature of 70°C. for half-an-hour with subsequent cooling - will also kill these bacteria. The bacteria, which normally inhabit the mammary ducts of the cow, and which cannot be excluded even with the utmost care and cleanliness belong to this group. (2) The butyric acid bacilli. These are strictly anaërobic and spore-bearing. They rapidly decompose milk when stored in closely-stoppered bottles, with strongly acid reaction, coagulation and formation/

formation of butyric acid and gas. Their spores are killed by an exposure of one to one hour and a-half at a temperature of 100°C. To this group belongs Klein's bacillus enteritidis sporogenes.

(3) The bacillus subtilis group. These are aërobic spore-bearing bacilli, but are capable of growing under anaërobic conditions. They decompose milk with faintly acid or unchanged reaction, coagulation of the casein, and subsequent liquefaction of the coagulum. Hence Flügge called them the "peptonising" bacilli. They are characterised by an extraordinary rapid rate of growth at high temperatures (25°C and upwards), comparatively little growth taking place below 22°C. Their spores are more resistant than those of Group 2, most of them requiring for destruction an exposure of at least two hours to 100°C.

Flügge has called attention to the importance of these "peptonising" bacilli in the causation of summer diarrhöea. The mortality is practically confined to infants fed upon cow's milk, and according to Flügge, occurs, despite the fact that the milk is boiled. Suspicion is thus cast upon the "peptonising" bacilli, since they grow rapidly at the temperatures in question, without producing much obvious change in the/

the milk. The anaërobes of the second group are less likely to do harm, as they speedily curdle milk and render it obviously unfit for food. Flügge isolated twelve species of "peptonising" bacilli from samples of market milk. Three he found to be definitely pathogenic to mice, guinea-pigs, and rabbits, when injected subcutaneously or intraperitoneally. When milk-cultures of these bacilli were given to young dogs they drank the milk readily, and immediately suffered from diarrhoea, which was fatal when the feeding was continued. Similar experiments with the acid-forming anaërobes failed, because the dogs refused to drink the milk.

Flügge's investigations led him to the conclusion that most of the so-called "sterilised" milk on the market is unreliable and likely to cause harm. He suggests that it should be made compulsory to change the word "sterilised" on the labels to"heated milk, not sterile, must be kept at a temperature below 18° or used within twelve hours." Lubbert confirmed Flügge's results, and found that after boiling the milk-culture it was no longer pathogenic, either when injected or given by the mouth. This is important and from a practical standpoint. He also made the interesting observation that while the milk-culture caused/

caused fatal diarrhoea in young puppies, it was harmless to older dogs. Weber examined 150 samples of "sterilised" milk from Berlin shops, and found only 54 per cent sterile.

If Flugge be right in thinking that the peptonising bacilli play the most important part in the causation of summer diarrhoea the objection to partially sterilised milk is serious. But milk ordinarily turns sour without putrefying. The lactic acid bacilli may be regarded as beneficial, as they inhibit the growth of the"peptonising" or putrefactive bacilli. At the same time many of the intestinal disorders of infancy may be prevented by boiling milk - an indication that the bacilli of Group 1 are the real culprits. At the depot of the Leith Corporation the bottles are placed after being filled in a steam steriliser and exposed to a temperature of 212°F. for half-an-hour. Only fifteen per cent of them were found to be sterile. The percentage of sterile bottles varied from day to day. This could be due only to variation in bacterial contamination of the original milk. The majority of the bottles which coagulated showed strongly acid reaction, gas-formation, and the characteristic smell of butyric acid. The remainder gave a faintly acid/

acid reaction and uniform coagulum.

Thus the designation "sterilised milk", as applied to milk sold from corporation depots, is misleading. Dr. W. Robertson, M. O. H. of Leith, and Dr. W. Mair, lecturer on Bacteriology, Queen's College, Belfast, in the Brit. Med. Jour. of May 14th 1904, have called attention to this serious misapprehension. They do not deprecate the preparation of milk for infant feeding. They suggest the substitution of the term "milk prepared for infants". Imperfectly sterilised milk allowed to stand in warm rooms soon becomes a source of danger. Every customer should be instructed as to the necessity of keeping the milk as cool as possible. This is especially necessary in summer, when the temperature often exceeds 70°F. Faith in the powers of steam sterilisers should not be too implicit, and in hot weather each day's supply ought to be sold as it is prepared. All "prepared" milk should be stored in cool places.

The ideal milk is milk which has been secured from a reliable dairy in which all modern sanitary laws are so applied that the hygienic condition of the cow's stable is perfect. That is to say, the teats, udders, and flanks of the cow, and the hands of/

of the milkers, should be clean, and all milk should be filtered, cooled, and, if possible, sold in sealed cans or bottles. But these regulations are difficult to enforce, and the conditions of the ordinary dairy fall far short of them. If milk is bought from the average dairy in a large city, it is rarely less than twenty-four hours old. Such milk certainly requires pasteurising or sterilising if one is compelled to use it for the feeding of infants. It must not be supposed that sterilising or pasteurising milk which is contaminated with either pathogenic or non-pathogenic bacteria will alter its quality, for one cannot convert an impure milk into a pure milk by any steaming process yet devised. Toxins contained in milk, which are always elaborated by micro-organisms, cannot be destroyed even by subjecting the milk to a temperature of 300°F. Public benefactors commence at the wrong end when they seek to convert milk contaminated with bacteria into a sterile fluid by steaming. What is gained by means of the boiling or steaming of the milk is simply the destruction of a large number of bacteria. It is impossible to destroy all micro-organisms unless the milk is subjected to Tyndallisation, which really means renewing the sterilisation/

sterilisation on three successive days for a given time. That this is impracticable and next to impossible is at once apparent.

Objections to sterilised or steamed milk consist in the fact that the heated milk has undergone chemical changes. The latter are chiefly found in the casein, which is rendered much more indigestible when heated. All heated milk has a tendency to constipate, and it is only necessary to compare the stools of two children - one child being fed on raw milk, the other on heated milk. It will be found that the degree of digestion of the "raw-milk" baby will be far greater than that of the "steamed-milk" baby. In other words, the stools of a baby fed on raw milk will be of a more homogeneous consistency than that of the other baby fed on sterilised or pasteurised milk.

The greatest objection to feeding with sterilised milk consists in the fact that the majority of such children offer a greater tendency to the development of scurvy and rickets. Milk that is steamed or boiled lacks the element of freshness, which it is known will produce scurvy, just as when an adult is deprived of fresh meat and green vegetables.

K, Oppenheimer, in Munich, published a series of experiments/

experiments in the Deutsche Medicinische Wochenschrift of Feb. 14, 1901, showing that milk generates H_2S when heated longer than five minutes. He used filtering-paper saturated with acetate of lead, and noted the increasing brown-black deposit, depending on the length of time the milk was heated. Thus, while milk heated five minutes showed a brownish colour, that heated twenty minutes converted the filtering-paper saturated with lead solution into an intense blackish-brown colour. Oppenheimer therefore stated, basing his belief on the results of his experiments, that the albuminoids, or more properly speaking the albumin, in milk is decomposed, as proven by the liberation of sulphuretted hydrogen, after milk is heated five minutes or longer in a steamer.

Undoubtedly it would be a great advance to have a supply of a clean and bacteriologically safe milk; still on the other hand, unsuitable modification of pure milk may be almost as disastrous as the use of impure milk. The importance of exact methods, in modifying the percentage of the various constituents, is that for a given case one can determine intelligently what/

what variations can be employed. But in the majority of infants these precise and unvarying percentages are certainly not necessary, while on the other hand there are cases in which even slight variations in the percentages of the various constituents produce effects either good or bad. Although some infants may flourish on almost any modification of cow's milk, correct or incorrect in theory, it still remains true that for the majority more careful modification of milk is necessary, and probably no one constituent gives more trouble than the curd-forming proteid, caseinogen. To avoid this difficulty of digesting curd, dilution is often carried to a degree which renders the mixture too weak to have its proper food-value, or resort is had to peptonisation, which is objectionable on several accounts.

Since maternal milk is universally recognised as the standard which should be imitated in the artificial feeding of infants, it is desirable at this stage to offer some remarks on its characters and composition.

Mother's milk consists of an emulsion of small fat droplets in which salts, sugar, and proteids are held in solution. When lactation is at its height it is bluish-white and semi-transparent, of sweetish taste/

taste, odourless, alkaline reaction, and its specific gravity ranges from 1030 to 1035. Its specific gravity varies with the amount of fat and proteids. Microscopically it consists of two parts: I. a clear fluid plasma, which contains proteids and salts in solution; II. globules of fat suspended in the plasma. They vary in size from $\frac{1}{3000}$ to $\frac{1}{12,000}$th inch in diameter. If the milk is allowed to stand, the fat globules rise to the surface in the form of cream.

The composition of maternal milk in general resembles that of any other mammal; the same proximate principles or food-stuffs are present , but they differ considerably in their relative proportions. These constituents are :

1. Nitrogenous. 2. Hydrocarbons or Fats.
3. Carbohydrates. 4. Mineral salts. 5 Water.

1. The nitrogenous or proteid elements of mother's milk are made up of: (a) casein, or more accurately speaking, caseinogen, which is precipitated by acids, and also by a special ferment, rennet, in the gastric juice. (b) Lactalbumin, which is not precipitated either by acids or by rennet, but is coagulated by boiling/

boiling. (c) Another proteid described as present is lactoglobulin. The proteids are partly in solution and partly in suspension (Rotch). The casein is in suspension by virtue of the presence of calcium phosphate, with which it is probably combined, while the lactalbumin is in solution and resembles serum-albumin (Holt, Monti).

2. The fats consist of palmitin, stearin and olein, and a small percentage of glycerides of the fatty acids.

3. The carbohydrates exist in mother's milk in the form of lactose or milk sugar.

4. The salts consist of phosphate, silicate, sulphate and carbonate of calcium; carbonate of magnesium; carbonate, sulphate and chloride of potassium; chloride of sodium; oxide of iron and alumina (Rotch). The sulphates and carbonates probably do not exist in milk as such, but are derived from the combustion of the sulphur of the proteids and carbon in organic combination (Richmond). There are also small quantities of lecithin, nuclein, cholesterin and neurin.

The proteid percentage is very high in the first weeks after birth, diminishing after the 30th day. From the 60th day there is a more decided and rapid fall in the proteid content. After the 70th day a low/

low percentage of proteid is constant though uniform in composition, (Schlossmann, Archiv. fur Kinderheilkunde, Bd. XXX). At all times of lactation analysis of the breast-milk will show greater or less variations in the proteid content. There is a percentage of 1.4 of soluble proteids in mother's milk in the form of lactalbumin and lacto-globulin. These substances represent seven-tenths of the total proteid content (Still). They are readily digestible, and are present in large proportion during the first months of life, when the child's powers of assimilation are little developed.

The percentage of fat in mother's milk varies normally between three and four and a half. Below two and over five are abnormal. Lehmann's average in forty cases was 3.8 per cent. Fat is the most variable constituent in mother's milk; the proportion is not affected by the period of lactation. Parkes and Kenwood state that as the woman's age increases the fat gets less, and the proteid higher. The fat of mother's milk differs from that of cow's milk in containing fewer volatile acids; it is also in a much finer state of emulsion, and is therefore easier of digestion. In mother's milk the infant obtains

a/

a food decidedly richer in fat than is present in any artificial food. It is usually well digested, even when it is excessive in amount.

The percentage of sugar is a very constant one, ranging from six to seven. It is lowest during the colostrum period; from that time on it steadily increases throughout lactation. The average percentage of sugar at the height of lactation may be estimated at six and one-half. It is readily assimilated. The carbohydrate group of food-stuffs is of value for the production of heat, and as a source of muscular energy. In a child at the breast its chief value is the former; in an older child it is required for both purposes. Infants practically never suffer from deficiency of carbohydrate-food - the percentage in human milk varies very little; in artificial feeding there is commonly too much of it.

The salts in mother's milk average 0.2 per cent. They are highest at first and diminish steadily during lactation. The growing infant requires a considerable amount of inorganic salts for the development of its bones, teeth and other structures.

The variation in specific gravity depends upon the fat or the proteids. The higher the proportion of fat the lower/

of fat the lower the specific gravity, whereas a decrease raises it. The proteids and other solids have a reverse effect. Consequently, if with a high percentage of fat the specific gravity is high the proportion of proteids must be above the average; if with a low proportion of fat the specific gravity is low, the proportion of proteids must be below the average. If the proportion of fat is normal, then the specific gravity will vary directly as the proportion of proteids.

To sum up, from an analytical point of view, the standard proportions of the different elements for infants may be given as: (Still, Infant Feeding, Ency. Med., Vol. V.).

HUMAN MILK.

Proteids:	Casein.	0.6	2.0
	Lactalbumin.	1.4	
Fat			3.5
Sugar			7.0
Salts			0.2
Water			87.3
			100.0

The/

The ratio of nitrogenous to the non-nitrogenous elements in woman's milk is about 1 to 7.6; in cow's milk it is 1 to 2.3.

The proportion of each constituent is subject to variation at all times of lactation. Constant alterations occur from hour to hour and day to day. Koeppe suggests that the poor results often obtained from the use of carefully selected pure and sterilised milk are due to its uniform consistence, whereas nature's product shows constant variations. In this respect the sugar and salts are the more constant in their proportions, whereas the fat and proteids show considerable variations.

From a clinical point of view the commonest and most serious defects in breast milk are excess of proteid and deficiency of fat. Upon one or other of these two faults depend most of the gastro-intestinal derangements of infants at the breast. If the infant does not make proper progress, before resorting to weaning, one should endeavour to determine which factor is at fault. It is usually found that there has been some error in the mother's habits or diet to account for these faults which can sometimes be corrected/

corrected by very simple means.

Since the occasion for Artificial Feeding is not only total defect of the maternal supply but unsuitability also, some of the conditions which may make the milk an unsuitable food may be mentioned. The conditions are chiefly those which necessitate the exhibition of drugs - castor oil, iodides, opium, santonin, alcohol (?), and many other drugs are partly excreted by the milk. In chronic constipation probably the maternal auto-intoxication may result in the contamination of the milk sufficiently to occasion symptoms in the child. Domestic and other worries, if they do not inhibit the secretion, seem to have some obscure effect upon the quality of the milk; but the writer does not know of any analysis in support of the fact.

The Digestion of the Infant.

Acute enteritis and gastro-enteritis, though so fatal in infancy, do not often cause death in adults. This is due largely to the anatomical and physiological differences which exist between the digestive tract of the infant and that of the adult. The chief function of the adult stomach is to bring the food into/

into a condition suitable for treatment by the small intestine, and not to allow it to pass until it is warmed, kneaded and reduced to a proper consistency. The full protective action of the gastric secretion is based upon the action of combined "pepsin-hydrochloric acid" and is digestive in character. During the early months of life the secretions of the stomach- those of hydrochloric acid and pepsin - are deficient in quantity when compared with those of a healthy adult. As the fundus is slightly developed the stomach is a tube-like structure, which, being placed almost vertically, is almost useless as a reservoir, and discharges the food into the duodenum so rapidly that it is empty two hours after nourishment is given. Though the gastric juice of infants has much the same properties as that of adults, the full benefit of its disinfecting property is lost if the child is brought up by the hand, for the casein of cow's milk fixes the greater part of the hydrochloric acid. The baby's stomach is therefore little protection to the intestine, and allows most of the injurious substances which enter it to pass on unaltered.

The writer does not know that any work has been done in the infant upon the lines of Starling's Croonian/

Croonian lectures of 1905, but it may be open to question whether the very intricate and complicated interaction of reflexes, in the relation of the various digestive secretions, is completely established during early infancy. For instance, Starling showed that unless the combined nervous reflex closure of the pylorus and formation of prosecretin stimulating the pouring out of the alkaline pancreatic juice at the proper proportionate rate, were duly effective, the duodenum and jejunum might be suddenly flooded with acid chyme, a condition which in the dog leads to pronounced toxic symptoms often fatal. It is easy to believe that, in the infant such an occurrence is liable to happen with equally disastrous results, hence acute enteritis of the lethal type.

The intestine of the infant is relatively longer than that of the adult, and the mucous membrane and lymphatics are developed at the expense of the muscular system. The absorptive function preponderates over the motor, and the pancreatic juice, like the saliva, has little power to convert starch. The saliva and pancreatic secretion only gradually acquire their full amylolytic power; in fact it is only towards the end of the second or beginning of the third year that the digestive functions approach in capacity those of the fully/

fully developed organism.

As a rule the salivary secretions are not present in sufficient quantity to possess any considerable diastatic action on starchy substances before the fourth to the eighth month, - that is, about the period of commencement of dentition (Judson and Gittings). The pancreatic secretion, which plays the most important part in the digestion of starch does not attain its full amylolytic power until the end of the tenth or eleventh month (Still). Hence the carbohydrate element in food must not be supplied in the form of starch during the earlier months of life; it is supplied however in the milk in the form of milk-sugar or lactose. The difficulty in digesting such articles as bread, potatoes, or any of the numerous so-called "infant foods" which contain unaltered starch, can therefore readily be understood.

The lactose is absorbed under one form or other almost entirely by the stomach; a minimal part is absorbed from the intestine (Judson and Gittings). How this is accomplished is not yet definitely established, whether by the action of hydrochloric acid, or microbes of lactic acid fermentation, or of a special ferment (lactase) which splits it up into glucose and galactose, which are directly absorbable. Undoubtedly a portion/

a portion of the lactose undergoes lactic acid fermentation in the intestines.

The peptonising powers of the gastric juice are but ill developed compared with those of older children; any but the most easily digestible of proteids quickly overtax the infant's stomach. By test-tube experiments the casein of cow's milk is found to clot in large homogeneous masses which are rich in fat and must be difficult of digestion; mother's milk, on the other hand, coagulates in fine flakes, poor in fat, which are without doubt more accessible to the action of the gastric juice. If one removes the gastric contents from a nursing infant half-an-hour after the meal, it is found that the chyme is almost completely liquid and filters easily, while if the child is being fed on cow's milk, at the end of three quarters of an hour casein clots are still present in the stomach. It may be concluded, then, that woman's milk is digested almost entirely in the stomach, but cow's milk only partially. While the secretion of hydrochloric acid seems to be sufficiently plentiful for the needs of the healthy breast-fed infant, it would seem that the artificially fed child requires more hydrochloric acid for the purposes of digestion, owing either to the greater/

greater saturating power for acids of the casein of cow's milk or to the greater preponderance of the albuminoids in the latter. Hence comes the greater frequency of gastric fermentation in bottle-fed babies, since the normal bactericidal action of the hydrochloric acid is feeble or absent.

The time of gastric digestion (Marfan) varies in different subjects and according to the kind of food given. In general it may be said that in the healthy nursing child the stomach is emptied from 1½ to 2 hours after the meal; if the child is fed on boiled or sterilised cow's milk the time required will be from 2 to 3 hours; while raw cow's milk does not leave the stomach until 4 hours after its administration, according to Reichmann.

The muscular wall of the stomach is relatively thin during the early months of life and peristaltic movements are doubtless feeble in the newborn. But woman's milk, after the coagulation of the casein, remains almost liquid; it can be digested without being churned in the stomach; it is evacuated the more easily into the intestine since it is assisted by gravity, the position of the stomach being nearly vertical. When the child is nourished with cow's milk, the volume of the clots must increase the difficulty/

difficulty of peristalsis. This is doubtless one of the causes of the tardy and imperfect digestion of cow's milk by the infant.

To sum up the digestive capacity of the infant: the casein is only partially digested in the stomach especially when cow's milk is the child's food. Pancreatic digestion plays the chief role in finally converting the casein into a form in which it can be absorbed by the duodenum and jejunum. Owing to the small amount of the gastric and the pancreatic secretions, the digestion of the proteids of milk (especially of cow's milk) is often imperfectly carried out during the first months of life. In the healthy breast-fed child the proteid residue is small and intestinal putrefaction is not a marked feature of digestion. The power to split up neutral fats is feeble during the first months of life; so also is the power to digest starch. Normally, a considerable portion of the fat is excreted in the stools. Milk sugar is readily digested by the infant and normally leaves little residue. It seems probable, in the light of recent investigations, that the enzymes which have been found in the intestinal secretions and in mother's milk play a not considerable role in the infant's digestive processes. These enzymes have diastatic properties/

properties. That which is present in mother's milk has intense saccharifying qualities, which are not present in that of cow's milk. Marfan has found a fat-splitting ferment (lipase) in mother's milk, which is very active. It is also present in cow's milk, but is less active.

An artificial food must contain nothing that is not found in human milk; it must be of animal origin and it must be fresh. The food must preserve its anti-scorbutic property. The anti-scorbutic power of milk is not great, hence it must be given in quantity. The artificial mixture must contain a due proportion of the proximate principles of food, and should be given in amounts suitable to the physiological and digestive conditions in infancy. If it is deficient in proteids the child becomes anaemic, languid, debilitated and short of breath on exertion. The muscles are soft and flabby and the child ceases to grow. Dentition is delayed and rickets may develop, for the salts are diminished if the proteids are deficient. On the other hand if there is too great a proportion of proteids the child suffers from indigestion, colic and constipation. The stools are green/

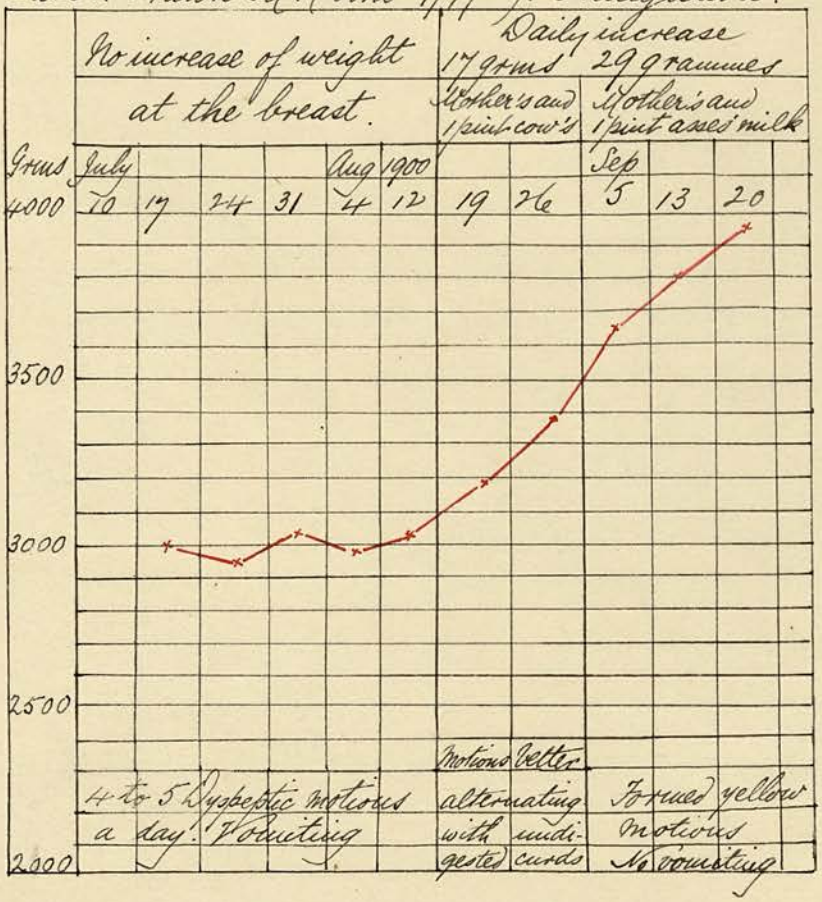
green or yellow, and contain curds. If the fat is deficient in amount the child suffers from constipation, its bodily heat is not maintained, and indirectly the structure of its nervous tissue and bone marrow is impaired. Should there be excess, which is quite unusual in the artificial mixtures commonly ordered, there is vomiting, diarrhoea, and wasting. It is in relation to the carbohydrate element that infants most suffer during the first year of life when brought up by hand. Almost all the condensed milks and patent foods contain an excess of carbohydrate, generally in the form of starch or cane sugar. The infant fed on these foods becomes fat, flabby, unwieldy and rachitic. There results intestinal derangement from fermentative changes set up in the alimentary canal, with the production of flatulence and diarrhoea.

The amount of food to be given at each feeding must be carefully regulated according to the gastric capacity. The average capacity of the stomach, according to Dr. Holt, is at birth $1\frac{1}{5}$ oz., at three months $4\frac{1}{2}$ oz., at six months 6oz., and at twelve months 9oz. Another estimate is: five days old 6 drachms, one month 2 oz., three months $2\frac{1}{2}$ oz., five months $2\frac{3}{4}$ oz. For practical purposes it may be estimated/

estimated as equal to $\frac{1}{100}$th part of its original weight and an increase of one gramme daily allowed up to the end of the first month (30 grammes = 1oz.) Working from this physiological basis, the writer's practice when present at parturition is to weigh the child and feeding is commenced with the quantity thus estimated. Should the child weigh 6½lb., 1oz. of milk food is given every two hours during the daytime for the first week; for the second week 1¼ oz., the third 1½ oz., and for the fourth 1¾ oz. Should the child weigh 9lb., 1½ oz. every two hours is given in the daytime. Ten feedings are given in the 24 hours for the first month. The increase in the stomach capacity is very regular; if 1 oz. at birth it will increase 1 oz. each month afterwards up to a certain age when the increase is not so rapid, so that the quantity to be given is the number of ounces the child is months old - for example, if three months old then give three ounces.

In the selection of a substitute for mother's milk the milk of the ass for those who can afford it is sometimes successful. In the city of Armagh there exists a nursery for delicate children, at which a stud/

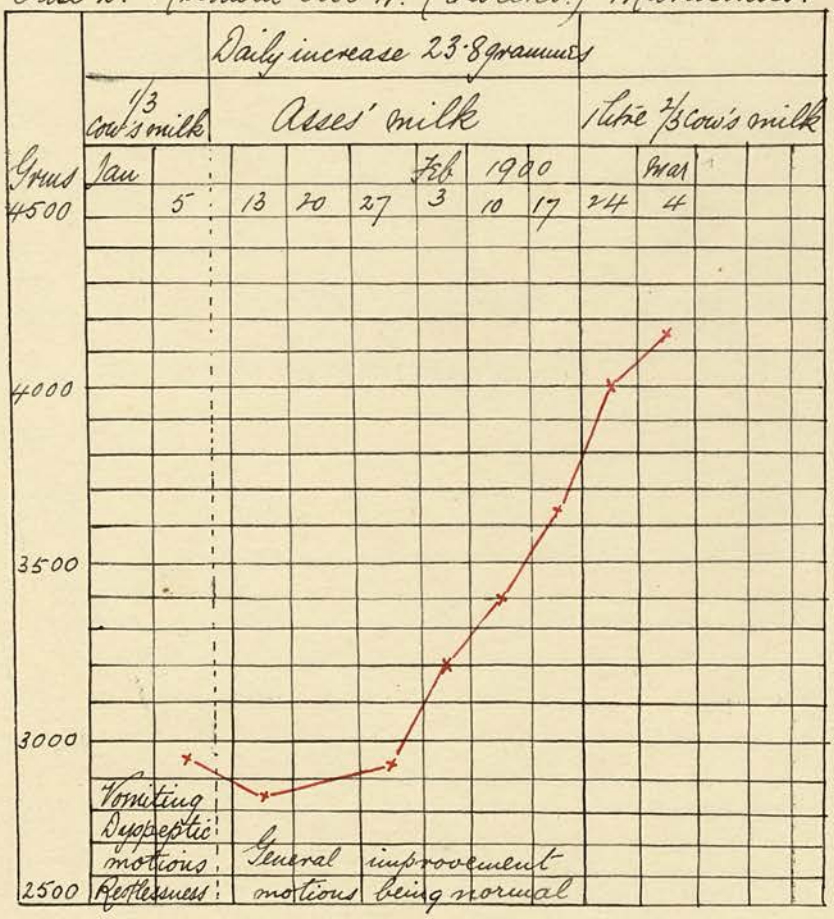
Case I. Frank M. (born 17/7/00). Indigestion.



stud of milch asses is retained for infant feeding: Two cases of infants improved by asses' milk may be here given.

1. F. M., male, born 17/7/1900; mother primipara in good circumstances and healthy surroundings. The infant at birth weighed 3000 grammes (6lb. 8oz.) and was fed at the breast. Its mother had plenty of milk but the infant shortly began to exhibit symptoms of indigestion. Fretfulness, sleeplessness, flatulency with colicky pains and vomiting were apparent, and the child appeared unsatisfied with the breast milk. For the first week its weight fell about 3½ oz., the second gained about 4½ oz., the third it lost 2 oz., and at the end of the fourth week it weighed 3000 grammes. There was practically no increase of weight. During this time the child suffered from vomiting of curd and passed from four to five dyspeptic motions daily. From August 12th it received its mother's milk with one pint daily of fresh cow's milk diluted one-third, with cream and sugar added. The child gained on this dietary 17 grammes daily - about 4 oz. weekly- till August 26th; its motions were better alternating with undigested curds. One pint daily of fresh asses' milk was then allowed to be given alternately with its mother's/

Case 2. Richard Mc W. (6 weeks.) Marasmus.



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mother's milk. The result was that the child gained 29 grammes daily - about 7 oz. weekly; there was a cessation of the vomiting and it passed formed yellow motions. Its weight on September 20th was 3950 grammes - almost 8½lb. At this time the mother's milk appeared to agree with the child as its improvement was maintained by the breast alone.

2. R. Mc. W., male, age 6 weeks; mother anaemic and without milk. Its weight at birth was 6lb. 4 oz., and it was fed on $\frac{1}{3}$ milk mixture for the first six weeks. Its weight when it first came under observation on January 5th was 2950 grammes. During the following week it suffered from restlessness, vomiting, dyspeptic motions and marasmus; its weight fell 100 grammes. It was then fed on asses' milk, and gained a daily increase of 23.8 grammes - 6 oz. weekly. There was a general improvement and the motions became normal. It was then placed on $\frac{2}{3}$ cows' milk mixture, receiving one litre (35 oz.) daily. Its improvement was maintained, weighing 4000 grammes (8lbz 10 oz.) on February 24th, and 4150 grammes (9lb.) on March 4th.

All that is really interesting and necessary to know about the course of the illness and about the results of the system of nutrition, is to be learned from/

from the curves, without a detailed report of the history of the illness. In the first case an analysis of the mother's milk would have been instructive, but unfortunately it was not made. Nevertheless the child was not weaned. Gastro-intestinal disturbance is the most common indication that the milk is unsuitable. Possibly the breast was too rich in proteid. During the first weeks of lactation the proteid constituent is very high, diminishing after the thirtieth day. Again, an inactive life together with a diet too rich in proteid is responsible for this condition of milk.

Asses' milk differs from human milk in that it is deficient in every ingredient except sugar. It differs from cows' milk in the following respects:

1. It does not need dilution or boiling.
2. It is always alkaline.
3. It usually clots on boiling.
4. It gives a fine flocculent curd on the addition of acids or rennet.
5. It leaves no residue of nuclein or paranuclein on digestion.
6. It has a relatively high proportion of albumin to casein.

In/

In all these respects it closely resembles human milk. The most striking feature of its composition is its poverty in fat. Hence it is unsuitable as an habitual food for infants, but it is useful in tiding over attacks of indigestion or diarrhoea. The milk has also this important advantage that asses are very rarely the subject of tuberculosis.

Goat's milk is richer in cream and almost as rich in casein as cow's milk. The casein however is easier of digestion, as the curd given with hydrochloric acid is more finely divided than that given by cow's milk. Goat's milk is extensively used in the rearing of infants by the small farmer and labouring classes in this locality. Simple dilution with plain water was the only addition made to the milk. It was very rarely indeed that the writer met with any cases of gastro-intestinal trouble resulting from its use.

Cow's milk.

Although cow's milk does not approximate so closely to human milk in its composition as does the milk of the ass, it is yet found that practically it makes the best substitute for it. Some infants cannot take cow's milk, however modified; but the vast majority thrive on it. On such modifications of milk as diluting it once, twice, or thrice, and throwing in "a little/

"a little sugar" vigorous infants may thrive, but many failures, even with healthy infants will occur, and many more with weakly infants and with those whose digestion has already been impaired by disease or unsuitable diet. The difficulty in digesting cow's milk lies in the large proportion of casein which must be overcome without reducing the other important constituents to a harmful degree, or making the food too rich in them.

The following table shows the average composition of human and cow's milk:- (Still - Infant Feeding, Vol. V. Ency. Med.)

Cow's Milk.			Human Milk.	
Proteids: Casein,	3.25	4.0	2.0	Casein. .6
Lactalbumin.	.75			Lactalbumin. 1.4
Fat		3.5	3.5	
Sugar		4.0	7.0	
Salts		.7	.2	
Water		87.8	87.3	

The diluents commonly used to reduce the proportion of proteids are plain water, barley water, lime water, oatmeal water, and rice water. All the other constituents are diluted at the same time, so that the percentage of fat which was previously the same as in/

in mother's milk becomes too low, and the already insufficient proportion of sugar becomes even less sufficient. It is necessary, therefore, to add fat and sugar to bring the proportion of these up to the standard of human milk.

As the writer's charts show it formerly was his practice to prescribe $\frac{1}{3}$ milk, $\frac{1}{2}$ milk, etc. Under one month he allowed one part of milk to three parts of water with sugar and a little cream. Over one month one part of milk to two parts of water with sugar and cream was prescribed. If the parents complained about the milk not staying down, or causing flatulence, diarrhoea; if the infant appeared unsatisfied with the food, he then 'rang the changes' on the different diluents till everything appeared to pursue a more favourable course. Recent observations by Drs. G. F. Still and H. Ashby enabled him to understand the fallacies of this empiricism.

The addition of an equal quantity of any of the diluents mentioned will reduce the proportion of proteids in cow's milk to two per cent, as in human milk; but the relative proportions of casein and lactalbumin remain exactly as before, so that the casein is still much more than in human milk; this can be seen from the following comparison:

Cow's milk and water, 1 in 2.				Human Milk.	
Proteids:	Casein	1.63	2.0	Casein	0.6
	Lactalbumin	0.37		Lactalbumin	1.4
Fat		1.75	3.5		
Sugar		2.0	7.0		

Even if three parts of water are used with one of milk, there is still a slight excess of casein.

Cow's milk and water, 1 in 4.				Human Milk.	
Proteids:	Casein	0.81	1.0	Casein	0.6
	Lactalbumin	0.18	2.0	Lactalbumin	1.4
Fat		0.87	3.5		
Sugar		1.0	7.0		

To reduce the curd-forming proteid to the proportion of human milk, four parts of diluent must be added, thus:

Cow's milk and water, 1 in 5.				Human Milk.	
Proteid:	Casein	0.65	0.8	Casein	0.6
	Lactalbumin	0.15	2.0	Lactalbumin	1.4
Fat		0.7	3.5		
Sugar		0.8	7.0		

But milk is seldom diluted to this extent. Yet it is considered evidence of some peculiar weakness in digestion if an infant suffers from colic, vomiting,

or/

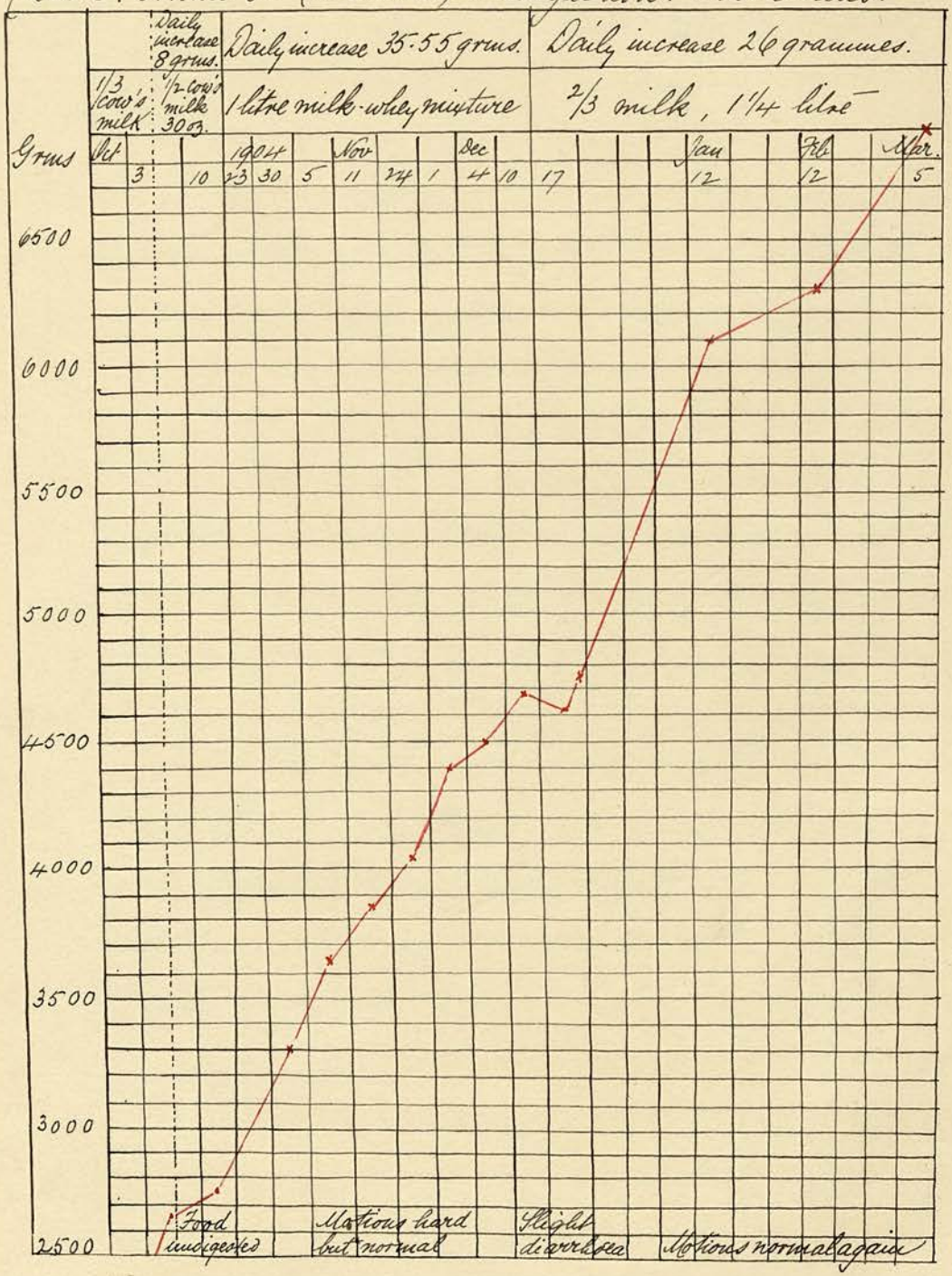
or other gastro-intestinal trouble, and fails to thrive when - say at eight weeks old - it is given milk diluted only with two parts of plain or barley water. The wonder is that so many infants manage to digest their food in spite of the excess of curd. Even the youngest infants have some range of accommodation in digestion; many can digest a larger proportion of casein than that in mother's milk. But a large majority of the failures with cow's milk are due to insufficient dilution. Extreme dilution is not advisable for the vigorous infant who can digest the larger proportion of curd - the more the better. More accurate modification of cow's milk is necessary, if only in respect to excess of curd, before rejecting it in favour of any of the far less satisfactory substitutes which flood the market. Though it is the proportion of casein, not the proportion of total proteids, which has to be corrected by dilution, the resulting total of casein plus lactalbumin should not be far below that of human milk. One should determine first the degree of dilution solely with reference to the proportion of casein which the infant can digest, and then rectify as far as possible the deficiency of lactalbumin, fat, and sugar.

There/

There is one ideal diluent - whey. Whey contains all the original constituents of milk except the caseinogen and most of the fat. When whey is made in the manufacture of cheese it should contain as little fat as possible as the fat is wanted for the cheese. But when whey is to be used as a food for infants, at least some of the fat should be retained and not rejected with the curd. This may be effected by thorough agitation of the curd before straining. Whey contains practically the same proportion of lactalbumin, salts and sugar as was originally present in milk. If therefore, whey be used as a diluent, however far the dilution be carried in order to reduce the casein, there will be no dilution of the lactalbumin. In the table of cow's milk and water, 1 in 4, the substitution of whey for water would raise the proportion of lactalbumin from 0.18 per cent to 0.75 per cent and the proportion of total proteids, therefore, from about one per cent to 1.56 per cent; and this increase is obtained without increasing the difficulty of digestion.

Chart 3. exhibits the case of a child which came under observation at the age of eleven weeks suffering from indigestion and wasting. At that date - October 3rd. 1904/

Case 3. Anna S. (11 weeks.) Indigestion. Marasmus.



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Erd 1904, it was being fed on cow's milk one part with two parts of water. A dietary consisting of equal parts of milk and lime water with cream and sugar was substituted. The emaciated infant in spite of much care still continued to whine and scream, suffered from flatulence and colic, its bowels were costive, the stools consisting largely of undigested curd. It only gained 100 grammes (3¼ oz.) for the week. The nurse then gave it a mixture of 10 oz. of fresh milk in 20 oz. of sterilised whey, with ½oz. of milk sugar. This quantity was later increased to 35 oz. The child rapidly gained weight and was more comfortable than when taking diluted milk. There was a daily increase of 35.55 grammes - about 8¾ oz. weekly. On December 10th cow's milk diluted with one-third part of barley water was substituted, with a teaspoonful of cream and milk sugar. There was light diarrhoea during the following week and lime water was tried. The motions became normal again, but the daily gain was only 26 grammes - about 6½ oz. weekly. Barley water has some advantage over plain water as a diluent in rendering curd more flocculent, and perhaps increasing to a very small degree the nutritive value of the mixture. Nevertheless it caused in this case flatulence, discomfort, and looseness of the bowels. Dr. Still believes/

believes that he has seen slight rickets result from its prolonged use.

Dr. Henry Ashby's method of preparing whey for infant feeding is to use Hawksley's sterilising apparatus, as the temperature can be regulated. Place 30 oz. of good fresh milk in the bottle, heat to 104°, add two teaspoonfuls of Benger's essence of rennet, and set aside for a few minutes. When curdling has taken place, thoroughly break up the curd by stirring and shaking the bottle; then strain through fine muslin or a colander. In this way 22 or 23 oz. of an opalescent fluid is obtained, which should be heated to 160° for twenty minutes, to destroy the rennin. It may require a further straining as more curd is apt to form on heating. The amount of fat is much larger than in whey prepared by simply draining the whey off the curd without agitating.

Whey so prepared, with or without 2 or 3 drms. of milk sugar to the pint, makes a useful food for newly-born infants who have to be artificially fed, or for infants who suffer from chronic vomiting, or have liquid, green, and curdy stools. They will gain weight and be more comfortable than when taking diluted milk. "Humanised milk" has been manufactured on a large/

large scale by mixing cream, milk, sugar, and water in various proportions and sterilising. It is generally overheated to make it keep for months. The casein constituent is only half that of cow's milk; it therefore still curdles; moreover it will not do to continue feeding with it, for (a) the casein is insufficient for a 6 - 7 months' child, and (b) it is not anti-scorbutic. Hence it is not as good a food as can be made at home by mixing cream or milk and whey and using the product fresh. A weak "humanised" milk may be made by adding 10 oz. of fresh milk to 20 oz. of sterilised whey, and adding ½ oz. of milk sugar. To make a "humanised" milk more rich in fat, use "top-milk" in the same proportion. Let a quart of fresh milk stand in a covered glass jar in a cold place for four or five hours; remove the upper 10 oz. by skimming; add this to 20 oz. of sterilised whey with ½ oz. milk sugar. It is well to add a grain or two of bicarbonate of soda, to render the mixtures neutral or slightly alkaline.

It is often convenient to give dyspeptic infants whey at first, or even to dilute the whey with a solution of maltose or barley water, as such infants cannot always digest as much as two per cent of fat in their food. As they improve, add milk to the whey/

whey, or "top-milk", as their digestive powers gain strength.

The advantages of whey over a solution of lactose as a diluent, are that it has anti-scorbutic properties, and contains soluble proteids and fat. Infants improve and gain weight after whey has been substituted for sugar or barley water as a diluent for milk.

When such whey is added to milk, take of whey two parts, milk one part, for an infant under six weeks. Warm to blood temperature (about 100°F.) for three minutes, then feed. This quantity (3 oz.) can be given every two or two and one-half hours. When feeding a child two to four months old: whey, 2 oz. milk, 2 oz. Feed every three hours. If this is well borne, gradually increase by adding an ounce of food; the formula will then be: whey, 2½ oz., milk 2½ oz. Feed every three hours. The general condition of the infant - its sleep, its stool, and its body weight - is an important factor in determining an increase in the quantity of food. If the child cries very much after feeding and appears hungry, then give: whey, 3 oz., milk, 3 oz. Feed every three hours. Some children at three months will take very readily six ounces of food. If the appetite warrants it, and the stool is homogeneous and well digested, then one/

one need not hesitate to give the following: whey, 3 oz., milk, 4 oz. Feed every three hours. The weight is the determining factor. If the child does not thrive, increase the quantity of milk and decrease the whey.

In the case of feeble and debilitated children sweetened whey instead of water may be ordered for quenching thirst. This is especially valuable in summer.

The obvious comments to the foregoing system of "whey in infant feeding" are that more than the average intelligence is wanted in the nursery to carry out details, and it is only adapted for use in families where the means are such as to permit the devotion of considerable time and no small pains to the infant's care. It is of the greatest importance in framing rules for artificial feeding that the physician make provision for those, who, from force of circumstances, or from imperfect education, cannot or will not, 'take trouble'

Alternative Methods.

In feeding infants with diluted cow's milk one may allow the following proportions: under one month - one part of milk to three parts of water with milk sugar 10 gr. to the ounce every two hours; over one month/

month - one part of milk to two parts of water with milk sugar 15 gr. to the ounce every two hours. Boil the water used for diluting the milk. The milk should at first be peptonised if the child cannot otherwise take it. Diluted to this extent it is greatly inferior to human milk, and, therefore, must be given of this strength only for a short time. If nutrition flags, add raw meat juice and cream. Gradually increase the proportions until two parts of milk and one part of water is reached. This gives proteids - 2.66, fat - 2.33, sugar - 2.66. Therefore 3.5 per cent of sugar must be added.

Pure milk cannot be taken before six months. But some cannot thrive upon it; even in most dilute form it may cause colic, vomiting, diarrhoea, etc. Its curd is too massive. To reduce the bulk of the curd the best methods are: (a) by boiling; (b) by adding bicarbonate of soda, 3 gr. to 1½ oz. of milk, or citrate of soda, 1 gr. to 1 oz. of milk. Barley water and lime water are less efficient. If boiled milk constipates, add a little liquid magnesia to each bottle. As alternatives for pure milk condensed or peptonised milk (pancreatic ferment) may be used.

Some of the diluents commonly used to reduce the proportion/

proportion of proteids in cow's milk have definite pharmacological and therapeutical activities that may be utilised by the physician. Barley water has a laxative effect that may be useful for an infant who is suffering from habitual constipation. Rice water and oatmeal water are sometimes used in the same way. The former has less laxative action than barley water and may therefore be useful where there is a tendency to diarrhoea. Oatmeal water, although it has a distinct laxative effect, contains less starch than barley water, and may agree where barley water has failed. The writer has seen cases of eczema and erythematous eruption following the prolonged use of oatmeal water as a diluent. Lime water may often be used with advantage instead of, or in addition to plain water. It has a definite though slight effect in diminishing the size and firmness of the curd; it also corrects the acidity of the cow's milk, and increases its digestibility. Lime water may be used in the proportion of at least one tablespoonful to a three-ounce mixture of milk and water. A solution of bicarbonate of soda - 2 gr. to the ounce - may be used similarly; it has the advantage that it does not cause constipation as lime water/

water often does. For this reason however lime water may be preferred as a diluent in cases of diarrhoea, and in such cases an ounce may be given in a three-ounce feed.

Condensed milk has its value as a temporary food, where it is impossible to obtain fresh cow's milk, or where an infant is unable to digest ordinary diluted cow's milk. The sweetened form keeps perfectly, but contains an excess of sugar - the children therefore often become flabby and fat. It is also deficient in cream, so that they are often soft in bone and rickety. It should at first be given in the porportion of one part diluted with 24 parts of water, and gradually increased to one part diluted with seven parts of water. If its use has to be continued several weeks the deficiency of fat should be corrected by the addition of ½ to one teaspoonful of fresh cream to each 3 - 4 oz. feed, so as to bring the fat in the mixture to at least three per cent. It may also be necessary to give raw meat juice once or twice a day to correct the deficiency of proteids.

The following case will serve as an example of how to feed with raw milk. An infant, seven months old, had been wet-nursed, and was brought for consultation with the history that the child had been well until/

until it was six months old, seemed to gain in weight from six to eight ounces weekly, and appeared satisfied after nursing. The stools had been quite regular up to one month ago; since then the infant's weight remained stationary, the stools had been of a greenish colour and contained many curds. The infant was very restless and wanted to nurse all the time; it did not appear satisfied, and seemed to cry most of the time. The breast milk was sent to an analyst, who reported the following:

Amount sent, 1½ ounces. Reaction - slightly alkaline. Specific gravity, 1.03105; Fat - 1.22; Proteids - 0.98; Sugar - 7.07.

It was also learned from the clinical history that the wet-nurse had menstruated quite profusely for one week, and during that time the baby seemed to be colicky. After receiving the above chemical report, which showed the deficiency of both fat and proteids, orders were given for the child to be weaned. The following food was then prescribed:

Raw milk, 6 ounces; Barley water, 2 ounces; Half teaspoonful granulated sugar; Pinch of salt. Warm the milk in a water-bath for three minutes before feeding. Feed every four hours. On alternate days were ordered:

Raw/

Raw milk, 6 ounces; Oatmeal water, 2 ounces; Half teaspoonful granulated sugar; Pinch of salt. Warm the milk before feeding, and feed the baby every four hours.

Thus the baby received one day oatmeal with milk, and the following day barley with milk. In order to give the child something that would act as a general tonic, tablets containing one minim of nux vomica were ordered, to be given three timesa day before the feeding, dissolved in a teaspoonful of water.

The stools were carefully watched, and the mother reported that twenty-four hours after commencing this raw-milk feeding the stools were yellowish, and the child seemed to be satisfied. One week following this plan of treatment the child gained six ounces, at the end of two weeks fourteen ounces more, making a total gain of twenty ounces in two weeks.

It must be understood that each child must be watched carefully, and that one must aim at the gradual substitution of whole milk, rather than give milk diluted with the cereals as above prescribed. If therefore, the appetite warrants it, seven ounces of milk can be given a baby, diluted with one ounce of rice - or barley water; this to be followed in a few/

few weeks - if the stools and the general gastric condition warrant it - by pure cow's milk.

In the case reported the white of a raw egg, with some sugar, was ordered, given with a spoon, and also some raw meat juice, or a concentrated soup made from meat containing sago, farina, or hominy, at noon, midway between the milk feeding.

The average child requires about one quart of cow's milk divided into five portions of eight ounces each. In addition a bread pap, consisting of crackers soaked in soup, will be found advantageous. It is worthy of note that three weeks after the above change from the wet-nurse to the cow's milk was commenced two lower teeth made their appearance.

The following practical points may be emphasised: An infant fed at the breast, which suffers persistent indigestion and at the same time fails to gain in weight, should be weaned. If, however, the infant gains in weight it is better to try and correct the indigestion by treatment directed both to the mother and child. To attempt artificial feeding in such a case often only adds to one's troubles.

In commencing artificial feeding begin with a weak mixture, and work up by frequent but slight changes to a point of tolerance. By still continuing a/

a gradual but steady increase, never beyond the point of easy digestibility, one can in a few weeks attain to a food sufficiently nutritious in all its ingredients and yet fully digestible and assimilable. It is a serious mistake to begin on a mixture too strong, and work down after weeks of indigestion, to the point of tolerance.

The question how long an infant should be kept on a modified milk diet is an important one. It is generally conceded that by the tenth or twelfth month a child should be able to digest almost pure milk. By this time, however, a mixed dietary is preferable. Milk is very deficient in iron. An infant comes into the world with a high precentage of haemoglobin; this gradually diminishes so long as it is fed on milk alone. Only when a mixed diet is substituted for a pure milk diet does the percentage begin to rise again. Cereals and meat juice and broths are rich in iron.

Oatmeal is amongst the richest in iron of the cereals, and properly cooked forms a useful addition to the infant's dietary. Shortly after the first twelve months eggs lightly cooked may be permitted at one of the meals in the day. The great richness of the yolk in fat, lime salts, and in the organic compounds of phosphorus and iron, makes it a valuable food/

food for the rapidly developing child. At this period, also, food involving somewhat long mastication, such as biscuits and crusts of bread, becomes necessary. The process of mastication develops the maxillary bones and the associated muscles, while disuse of the jaws starves the area supplied by the maxillary arteries, leading to their imperfect development. The bone remains small, the teeth are crowded and imperfectly nourished, and dental caries, so disastrous to the growing child, becomes inevitable.

The Feeding of Infants during Illness.

The advice of the physician may be sought for some infantile ailment which he finds has been the result of tinned foods entering largely into the diet. He suggests a trial of fresh milk only. Thereupon the reply often is, "My baby cannot take cow's milk". If one eliminates from the crowd of infants who are stated to be congenitally unable to digest cow's milk all those who have been over-fed, or too frequently fed, or fed on milk improperly prepared, it is found that there is only a very small residue who possess this undesirable quality. Assuming that one does meet with individual idiosyncrasies to milk in any form/

form, it should nevertheless be the physician's axiom that when intelligently employed some form of milk diet can be invariably found to suit the most capricious infantile digestion.

In various disorders of the intestinal tract, in marasmus of a certain degree of severity, and in other affections, it may be inadvisable to give ordinary milk. Weak, nutritious, easily digestible foods are often necessary.

1. Whey is very useful as a temporary food in alimentary disorders, marasmus and typhoid fever. By gradually adding cream or milk, a return to an ordinary milk mixture can be slowly carried out.

2. Peptonised milk is also very useful. It is best prepared by the use of the Allenbury or Fairchild's peptonising powders. At first it should be peptonised from 20 - 30 minutes, and given diluted with an equal quantity of water. Subsequently, the length of peptonisation is reduced as the child improved. The continued use of peptonised food weakens the digestive functions.

3. Albumin water is a valuable, pure, albuminous fluid, made from the white of an egg, with six to eight ounces of water and a pinch of salt. It can be/

be sweetened by sugar. Albumin water, sugar and cream mixed in suitable proportions make an artificial mixture which resembles human milk. It is a useful method of giving proteid to infants who digest the milk proteids badly, and as a temporary food in various conditions.

Among other temporary expedients when milk cannot be taken may be mentioned:

4. Bread Jelly. This is prepared by taking four ounces of stale bread crumb broken into small pieces; cover with boiling water and let it stand for six hours. Squeeze out the water and pass the pulp through a fine hair sieve. On cooling a jelly is formed. It must be prepared fresh twice daily, as it will not keep. It may be given in the proportion of a tablespoonful to eight ounces of water. Such a mixture contains: proteid 0.74, fat 0.13, carbohydrate 4.25. It is therefore far too weak except in carbohydrate. It is not antiscorbutic and contains no animal element. Boiled milk in the proportion of 1-2 oz. to the 3 oz. may be added to it. If the infant is absolutely intolerant to milk, one may add raw meat juice and cream. These supply the necessary proteid and fatty elements as well as the antiscorbutic principle. One tablespoonful of bread jelly added to 4½ parts of water/

water, 1½ parts of raw meat juice, ½ part of cream and a little sugar may be given to an infant.

In later months increase the strength to four part of water, three parts of raw meat juice, ½ part of cream and ⅕ part sugar. Be careful to add the meat juice when the jelly is cool.

5. Raw meat juice is an admirable food; it is rich in proteid, easily digested, and antiscorbutic. Up to 2 or 3 oz. may be given daily.

6. Meat peptones contain a very high percentage of proteid, but deprive the stomach of its proper work, and therefore are suitable only for an emergency. Somatose contains about 80 per cent of digested proteids. Dr. James Burnet speaks highly of sanatogen, which consists of milk albumin 95 per cent and 5 per cent of glycerophosphate of sodium, in the treatment of infantile atrophy (Practitioner, October 1905).

7. Condensed milk. The sweetened brand is also recommended by Dr. Burnet (idem supra) in the treatment of infantile atrophy, since this class of patient is unable to digest fat.

8. Buttermilk has been advocated as a food for infants, especially where there is chronic gastro-enteritis. G. Jacobson (Arch. de Méd. des Enf., Feb. 1903) considers/

considers buttermilk useful even for healthy infants, where breast feeding is impossible, but especially in cases of gastro-enteritis and indigestion. Its value lies chiefly in its easy digestibility which is due chiefly to its acidity, the low percentage of fat, and the extremely fine division of the already coagulated casein. Prof. M. Stooss (Corr. Bl. f. Schweizer Aerzte Nov. 1905) gives four cases proving the special service of buttermilk in cases of infantile atrophy resulting from chronic dyspepsia, in which there is no intestinal irritation. If diarrhoea alternates with constipation it is occasionally useful in the latter periods, but is harmful in cases of acute diarrhoea and vomiting.

9. Predigested carbohydrate foods and milk derivatives. In considering this group it must be clearly understood that the writer is discussing the feeding of infants during illness. During the first nine months of infant life the following dietetic principles have been endorsed by the highest medical authorities, and may therefore be taken for granted: 1. That breast milk is the best food for an infant; 2. that, failing this, fresh cow's milk and cream, suitably diluted, is a complete diet. It follows, therefore, that/

that the more the medical man knows of the many simple methods of adapting fresh milk to the needs of the infant, the less use he will find for condensed milk or patent foods. There is no doubt that rickets and scurvy are often due to the prolonged use of these preparations. On the other hand, some of them are of temporary value in certain pathological conditions and can be used with advantage. The various foods on the market may be classified as: 1. Peptonising powders, with without starchy matter; 2. dried milk; 3. condensed milk; and 4. starchy foods, nonconverted, partially converted, or wholly converted into soluble carbohydrates - dextrin, maltose or glucose. Of these the farinaceous foods, in which there has been little or no conversion of starch, such as Ridge's food, Neave's food, entire wheat flour, arrowroot, cornflour, sago and rice, cannot be regarded as in any way resembling breast-milk, or suitable for the physiological feeding of infants under the age of nine months, and in most cases are better avoided until the end of the first year. Farinaceous foods, in general are deficient in fat and animal element, and lack the antiscorbutic property of fresh milk. To increase the digestibility of the starch malt diastase or pancreatic ferments are impregnated in the/

the dry preparation. In this way some of them are partially, and others completely converted. The partially malted foods, prepared with water only, such as Allenbury's malted food No. 3, Mellin's, Benger's, Savory and Moore's foods, are absolutely unsatisfactory; but with milk and water may prove satisfactory, when a little cream is added, for children over three months.

The completed malted foods, such as Allenbury's milk foods, Nos. 1 and 2, Horlick's malted milk, generally contain too low a nitrogenous element, and are deficient in fat. They, therefore, should also be prepared with milk and water, or raw meat juice and cream. This class is more suitable to infants under three months.

If these "infants' foods" be used with an intelligent appreciation of their composition and properties, one may find that there are conditions under which they are suitable.

The chief indications for the use of an "infants' food" are three in number: 1. vomiting, 2. diarrhoea, and 3. wasting.

1. Vomiting. - The medical attendant will, of course, try to find out the cause of the vomiting, particularly since it is often due to an error in the feeding.

Failing/

Failing to effect a cure after careful examination and treatment, one may with advantage try predigested milk. The nutritive value of peptonised milk is probably less than that of fresh milk, but its chance of quiescence in a much harassed stomach is greater. Similarly, dried milk, either the whole milk or the remainder, after all the cream has been removed, may sometimes be tolerated and digested, especially if it is very well diluted. In other cases condensed milk may be successful. These are methods of resting the stomach by giving it less work to do than is required by the tough curds of fresh cow's milk, and in the digestion of fat. No added cream should be used under these circumstances, and the dilution should be carried far beyond the printed instruction on the tins, the object being not to fatten the infant but to rest the stomach.

2. Diarrhoea. - An acute attack of diarrhoea in an infant frequently necessitates the temporary disuse of fresh cow's milk. As the cause of this trouble is often traceable to impure milk, and the active poison flourishes in that medium, the usual practice is to discontinue milk entirely during the acute stage. In diarrhoea, or at least zymotic enteritis, as/

as seen in London, one often finds it necessary to cheat the organisms, or starve them into surrender by continual changes, thus:-

(a) off milk - on to albumen water for 24 hours.

(b) change to raw meat juice for 24 hours.

(c) change to white wine whey for 24 hours.

(d) back to very dilute milk or predigested milk.

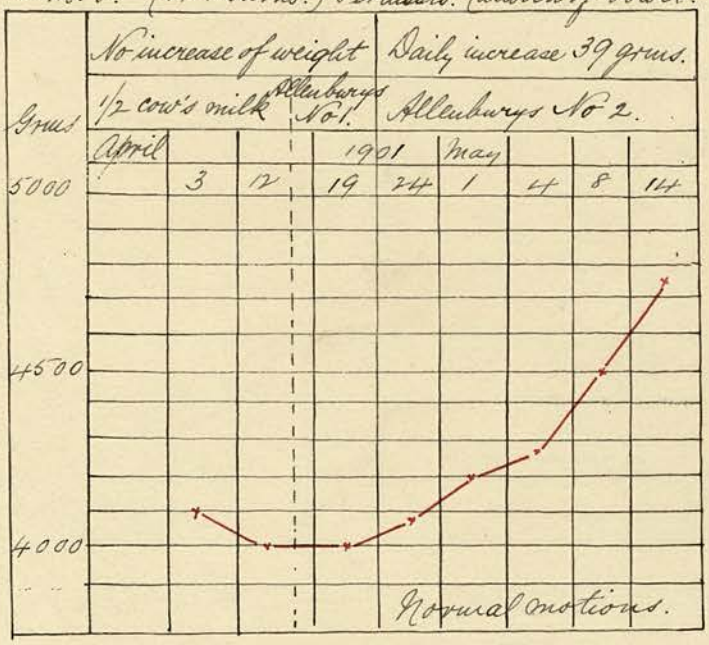
This is only a random list to illustrate a process sometimes successful in the midst of an epidemic, or where several cases have become grouped in one ward.

When convalescence has set in the irritable stomach and intestines must be treated very gently at first, and so a return to milk food is best made with predigested, dried, or condensed milk. In addition one may add in small quantities one of the starchy foods, if fully converted, as they are not specially favourable to the growth of the diarrhoea-producing organism.

3. Marasmus or wasting. - One frequently meets with infants who, with or without vomiting and diarrhoea, continue to waste in spite of every attempt to feed them on a pure milk diet. Probably many cases are due to a complete breakdown of the digestive organs, which have been sorely tried by "infants' foods" during the first few months of life. Here, again, one/

one is led to try some of the peptonising powders or foods or preserved milk. If prggress is made with füll predigestion one should then reduce the peptonising period to the shortest time possible. In other words, if improvement is secured by peptonising for half- an-hour, gradually reduce the period to fifteen or ten minutes, or even less, until the limit is found that is tolerated. By this means the stomach is educated to do a certain amount of its proper work, and time is allowed for the atrophied cells to recover their function. In such cases also the predigested foods, or the converted starchy foods, advertised for infants may serve to increase the nutrition. The latter class may be used along with cow's milk, first, because they mechanically aid the digestion of the milk, and, secondly, because they add certain food elements which the disordered stomach can retain and digest. In some infants, as in many adults, the drinking of plain cow's milk produces indigestion, but if the milk is mixed with some solid material the difficulty in the digestion is removed. In the case of young infants, however, one must not push this too far, or else the relief of one trouble will be followed by the supervention of others.
Whenever dried milk or condensed milk or a starchy food/

Wm. P. (4 months.) Pertussis. Catarrh of bowel.



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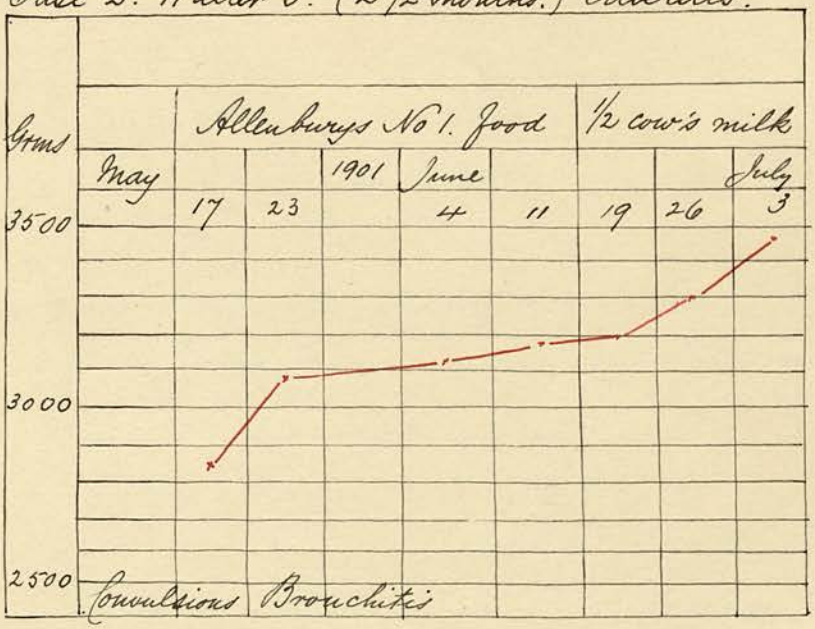
food is ordered the degree of dilution must be explicitly stated.

The first occasion on which the writer used an artificial food was five years ago in a case of pertussis with atrophy. William P., aet. four months. He was the first child of healthy parents, and was born at Sao Paulo, Brazil. The mother contracted puerperal fever after birth of child, and was ill for six weeks, the child being then weaned. The child was brought up on pasteurised native milk in the bottle, but feeding was unsatisfactory in all respects. Her doctor ordered her to return home with the baby. On board ship the child was fed on condensed milk. Here the mother states the child had no vomiting - "it was not in the least sea-sick". It had diarrhoea however after a while. This continued in spite of treatment by the ship's doctor. Whilst staying for a few days in London it contracted whooping cough. When it reached home it was greatly emaciated weighing only 4100 grammes. It vomited frequently after the spasms of whooping cough, and suffered from catarrh of the bowel. There was no improvement with milk and lime water. Allenbury's No. 1 milk food/

Case 2. Walter S. (2 1/2 months.) Enteritis.



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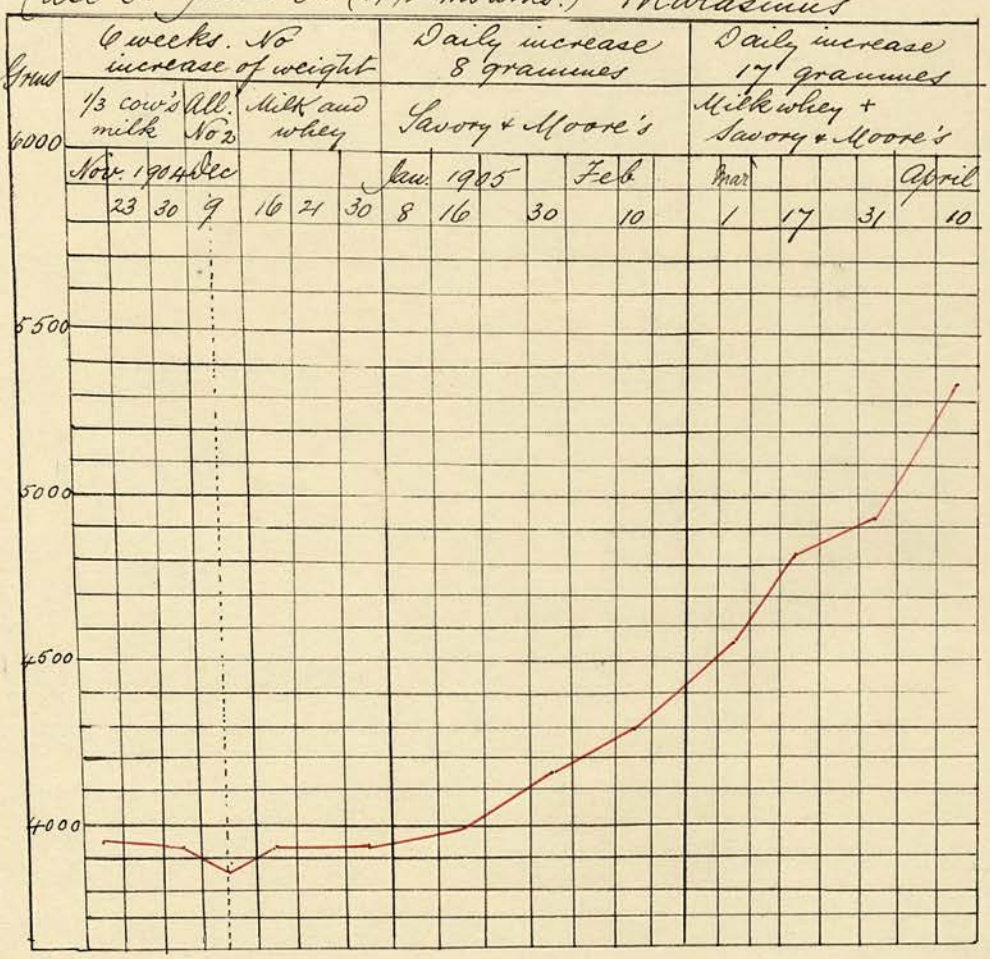
food was then tried. This was tolerated satisfactorily but the child did not gain weight. In addition to the dietary, it was put on a Cremor Bismuthi et Salol mixture and received frequent chest frictions with Roche's embrocation. The child was then placed on Allenbury's No. 2 milk food, when the mother was gratified with the immediate improvement of the child. She took its weight regularly, and the chart curve is here given. The baby liked the food; it agreed with it; the vomiting and disorder of the bowels disappeared; it fought its battle better with the whooping cough, and by degrees the infant completely recovered.

Case 2. - In this case there were chronic intestinal catarrh with offensive undigested stools and catarrhal bronchitis. The child aged 2½ months weighed 2850 grammes. It was attended at first for an attack of convulsions. There had been diarrhoea since birth, and later vomiting and cough. There was typical infantile atrophy. The child was fed on Allenbury's No. 1 milk food for twenty-nine days, and gained 300 grammes in weight. Diluted cows' milk was then given and was well borne, the weight increasing in twenty-two days by a further 300 grammes.

Case 3. - A child, aged 4½ months, weighed 3950 grammes. It/

Case 3. James O. (4½ months.) Marasmus



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It had been fed with cow's milk and a variety of diluents, but none agreed. Numerous furuncles developed about the neck, chest and face, and there was slight pyrexia. The faeces shewed but moderate digestion. Irrigation of the colon was carried out and the child put on Allenbury's No. 2 milk food. The child refused this after a few trials. It was then put on a milk-whey mixture. It took this but did not seem satisfied. Savory and Moore's Food was then given by the mother. The child took this voraciously, and its condition slowly improved. Better progress was then made by the further additions of raw meat juice and milk-whey mixture to the dietary.

These children did not suffer from disease of any of the organs, and particularly from neither syphilis not tuberculosis. They were mostly children who had been badly fed, whose bowels were out of order (dyspeptic or catarrhal motions), or who were in a condition where normal periods alternated with relapses to similar previous catarrhal conditions. The favourable state of nutrition of the children and their increase in weight continued, even if the artificial food, after a prolonged use, was replaced by ordinary cow's milk (compare curve 2, curve 3). This/

This appears most important, for it is a well-known fact that many infants fall away again and show the old pathological appearances in the bowels when the paticular food, on which they have been thriving, is discontinued.

The following case illustrates one of the disadvantages of "infants' foods", in which a child developed infantile scurvy.

L. A. M., a boy aged 1½ years.

Family history: Patient is the eighth child. The first six are alive and well, the seventh died when a fortnight old from weakness. The mother is aged 32.

Patient's previous history: Child was born at full term and the labour was normal. He was apparently quite well and healthy till 14 days old. Mother had to wean him then on account of deficiency of milk. Since then he has seemed weak and puny. He has been fed on Benger's Food and Nestle's Milk, chiefly since then. The mother says cow's milk and barley water was tried, but did not suit him. The child is a very fretful baby. Screams frequently in his sleep. Sweats considerably especially at night. Is often sick/

sick and is subject to cough (ascribed by the mother to "bronchitis"). When eleven months old child developed suddenly a swelling of the left foot. This was purplish red in colour and very tender. Child was still more fretful at this time. A month later (i.e., a month ago) he developed another swelling just above the left knee.

On examination, child is rather pale, but chubby. Lies quietly in bed when left alone, but cries on being touched or moved. Heart and lungs normal, except for a few rhonchi over the back. Ribs beaded. Abdomen protuberant.

Lower limbs:- At the lower part of the left thigh is a diffuse fusiform enlargement of the limb. The superjacent skin is tense and reddened. Swelling is tender and hot to the touch. Limb is held quite immobile. Similar swelling on dorsum of left foot. Other limbs show weak flabby muscles and lax loose ligaments so that the joints are unduly mobile. Skull large compared with face. Frontal and parietal eminences well marked. Temperature normal. Patient was put on antiscorbutic treatment, viz., raw meat juice, orange and lemon juice, potato-cream, and fresh milk.

Subsequently the temperature rose to 100° one day, and/

and a few days later to 101.4°, but in both cases it subsided without any change in physical signs.

The child improved fairly quickly, became much less fretful and apparently free from pain.

The following rules of procedure ought to be followed in all cases in which these "infants' foods" are being used:

1. Make sure that the packets or tins of"infants' foods" are supplied fresh.
2. In acute illness a return to natural feeding should be made during the latter part of convalescence and before the patient is discharged.
3. In chronic illness no "infants's food should be continued longer than is absolutely necessary. If the infant is apparently thriving well on the food, it will in all probability actually thrive better on a fresh milk diet. The change may be at first merely tentative.
4. In all cases where a predigested or preserved food has been used for more than two weeks, orange or grape juice (half an ounce) in water should be given daily to avoid the risk of scurvy.
5. Under similar circumstances the addition of fresh cream/

cream or cod-liver oil to the diet should be made as soon as possible, because the fatty element is usually deficient in all "infants' foods" (as prepared for use), and is essential.

Congenital Hypertrophic stenosis of the Pylorus.

As this condition has been shown to be not always fatal, even without surgical operation, one should first endeavour to alleviate the symptoms by carefully dieting, before risking surgical interference. Persistent vomiting associated with constipation are the main difficulties to be surmounted.

Dr. Gardner (Lancet, Jan. 10th, 1903) reports a case of recovery without operation. In this case whey was for a long time the principal diet. At first a teaspoonful of whey was given every twenty minutes. A little malt was soon added, dissolved in the whey; then barley and maltine were given occasionally. Gradually a little raw meat juice, or a little white of egg was added, and the quantity of food was gradually increased from one to two, three and four teaspoonfuls at a time, the intervals between the feedings being prolonged. The addition of a little milk to the food was tried but it did not suit./

suit.

Dr. Batten (Lancet, Dec. 2th. 1899) reports a case in which recovery resulted by the use of the nasal tube, the food administered being three to four oz. of cow's milk diluted with barley water every 2½ or 3 hours.

In the former case improvement commenced only when everything that could have left any undigested residue was discontinued and when only small quantities at a time were given. The pyloric sphincter was thus given almost perfect rest.

In the latter case when the actiye peristaltic movement in the stomach started by deglutition is relieved by feeding with a nasal tube the stomach will tolerate and digest the food that is placed within it.

The Preservation of Milk.

It is extremely important that the milk employed in infant feeding be obtained with such careful precautions as to render it practically free from contaminating bacteria. It is scarcely necessary to describe in detail the very numerous sources and occasions in which milk may become contaminated before it/

it reaches the consumer. Various conditions of local or general disease in the cows, such as tuberculosis of the lungs or udder, foot - and - mouth disease, pleuro-pneumonia, acute enteritis, and many affections of the udder (e.g. garget), cause the milk to deviate from the normal standard. The unhygienic condition of the dairy farms; the persons of those through whose hands the milk has to pass; the numerous utensils, only hastily and imperfectly cleansed, the source of the water with which they are washed, and so on render it difficult to obtain a reliable supply. Again, it is not always one's good fortune to be able to obtain the milk with a regularity necessary for the daily preparation of the infant's food.

When the supply cannot be depended upon one mode of treatment only will prevent the chance contamination of milk with the viruses of tubercle, typhoid fever, diphtheria, scarlet fever, etc., and that is some form of sterilisation. Treatment by heat, either in the direction of complete sterilisation or by pasteurisation, has been extensively used. Neither method is entirely satisfactory, but it appears the lesser of two evils to have the milk pasteurised at the lowest efficient temperature, viz., 150° to 157°F. The objection to sterilisation is that to be complete a temperature/

a temperature above 160°F. is necessary. Milk sterilised at over 160°F. is altered to an extent varying according to the elevation of the temperature employed and the duration of the exposure, in the following respects: the proteids are modified and rendered less digestible; the combination of the saline ingredients with the proteids appears to some extent to be broken up, and the salts assume a condition in which they are less readily absorbed, and an alteration takes place in the emulsion normal to milk which may also have a distinct effect in lessening its digestibility by the infant. Further, the natural ferments whose presence in milk is quite possibly bacterial in origin and which materially assist its digestion in the infant's stomach, are destroyed. Bacteria play an important part in normal digestion which it is found unwise to inhibit.

Milk obtained in the country from healthy pasture-fed cows, milked in the open fields, certainly is better not sterilised, but milk obtained in the city from more or less unknown sources, and under unknown conditions, should be pasteurised, especially in summer weather.

Pasteurisation, which consists in heating the milk to from 150° to 157°F., is not open to the same objection/

objection as sterilisation; all non-sporing disease germs are destroyed, the flavour is less altered, and the nutritive qualities are less diminished. But pasteurised milk is by no means sterile and its keeping qualities are not greatly prolonged unless the precess is followed by efficient, i.e., persistent chilling. There is a considerable tendency nowadays to run the milk rapidly through the pasteurising apparatus instead of allowing the milk to remain at the proper pasteurising temperature for twenty minutes or so, as should properly be done. Such a procedure would necessarily allow many pathogenic forms to remain alive and would engender a false sense of security.

Methods of application.

Sterilisation means, properly speaking, the destruction of all bacteria and spores, so that milk thus treated and protected from infection will keep indefinitely. This is accomplished by subjecting the milk to prolonged boiling in the usual way for an hour or more, or by the use of superheated steam. For domestic purposes an apparatus exactly similar to that used for pasteurising (q.v.) is most convenient; the temperature, however, is raised to 212°F. for not

less/

less than forty minutes. The spores of some micro-organisms, however, resist such a temperature for a much longer time. "Humanised milk" as sold in the shops is sterilised. Dr. Kingston Barton (Brit. Med. Journ., Janz 2, 1897) states that sterilised milk is easily prepared for infants by placing it in a china vessel which stands in cold water, the water being then boiled for 15 minutes. This method is devoid of danger of scurvy or constipation, and is, for all practical purposes, sterilised though not boiled. Professor Whitla advises the milk to be boiled in small bottles plugged with sterilised wool on a water bath for 15 minutes, the bottles thereafter to lie in a saturated solution of boric acid. This milk remains good for five days.

Sterilised milk, although free from poisonous germs, may produce scurvy unless mixed with some fresh milk or whey. Sterilisation devitalises milk, but one meal of fresh whey daily will prevent the onset of scurvy. Starr reported five case of scurvy in 1895 in infants fed on sterilised milk. Recovery took place rapidly on unsterilised milk, raw meat juice, orange juice, and citrate of iron. Dr. Henry Ashby relates a case in Brit. Med. Journ., Feb. 27, 1904, of scurvy in an infant fed on municipal "humanised" milk./

milk. He states that for every typical case of scurvy, at least half-a-dozen will be seen in which the infant has been fed on preserved foods, and show indefinite symptoms of scurvy, which may be called "para-scorbutic". The tenderness of the bones may be entirely absent, but there are anaemia, loss of flesh, distaste for food, sometimes diarrhoea of a dysenteric type, more rarely haematuria; there is, in fact, a condition of malnutrition and cachexia. Dr. Still has also noticed the same thing with overboiled milk (Encyl. Med. Vol. V.).

Pasteurisation of milk consists in keeping it at a temperature of 150° to 157°F. for twenty to thirty minutes, and then cooling rapidly. Various forms of apparatus are made for this purpose under the name of "sterilisers", this term being loosely used to include both pasteurising and sterilising apparatus. Soxlet's is suitable for home use, and moderately cheap; Rotch's apparatus is simpler; Hawksley has three kinds; while other forms of apparatus are: Contant's - 'the Tutelaire' - (Lancet, Feb. 12th 1891), Escherich's (Lancet, Feb. 1891), Starr's, Caille's, Seibert's, Warner's, etc. The principle is the same in most of these forms: the milk is placed in an inner vessel surrounded by a jacket of cold water into which a thermometer passes, the/

the water is slowly raised to a temperature of 150°- to 157°F. and the source of heat is then removed; the milk is left surrounded by this heated water for twenty minutes. An ordinary deep tin saucepan, with a wire or perforated tin tray suspended in it, as in a fish-kettle, so that the bottle of milk (stoppered with a plug of non-absorbent sterilised wool) may not be overheated by contact with the bottom of the saucepan, will suit the purpose admirably. Through a hole in the lid a thermometer is inserted which registers the heat of the water inside the saucepan. After twenty minutes the bottle of milk is taken out, the cotton wool plug removed and replaced by a tight-fitting stopper, the bottle is then rapidly cooled, and kept in some cool place until required for use.

The physician would do well to point out that the mischief often occurs after the pasteurisation, unless the actual vessel from which the milk is taken by the child is used to contain the milk during sterilisation. He therefore should point out the desirability of pasteurising the diluted milk, as ordered, in the infant's bottles. The teats ought to be sterilised and kept in boracic solution till required and must be substituted for the plug with clean hands. He should insist, too, on cleanliness in/

in the nurse - as to her hands and the infant's mouth, the bottles themselves, and so on. Elementary points, one may say, but just those important details which are apt to be neglected by those who are much impressed with an elaborate sterilising ceremony.

Dr. J. A. Coutts, at a meeting of the W. London Med. Chir. Soc., held March 2, 1906, read a paper on "Some points in Infantile Scurvy", and mentioned the cases of two children who were under treatment; he stated that the reason the cases had not rapidly recovered, was that the dairy company which supplied the institution had, unknown to the authorities, been supplying pasteurised milk instead of ordinary cow's milk. One of the children had died before this mistake was rectified.

"Buddeised" milk.

If one turns to the Lancet, Jan. 27, 1906, there will be found a most instructive article by Dr. R. Tanner Hewlett, of London, on "An experimental investigation of the Budde process for the preservation of milk". Here an oxidising agent - peroxide of hydrogen - is added to the milk: about 15c.c. of a three per cent solution per litre of milk: the mixture is heated to from 51° to 52°C. for at least three/

three hours. With the aid of heat the hydrogen peroxide is completely decomposed into water and oxygen by an enzyme (catalase) present in the milk, and the oxygen at the moment of liberation being in a nascent condition acts as an efficient germicide. The treatment was not found to alter in any way the colour, odour, taste and appearance of the milk, and the cream rises in a normal manner after the treatment. Hewlett proved conclusively that all the non-sporing organisms, pathogenic and non-pathogenic, dealt with - viz., the tubercle bacillus, the bacillus diphtheriae, the bacillus acidi lactici, the bacillus typhosus, the bacillus coli, the bacillus dysenteriae, a para-typhoid bacillus, the micrococcus pyogenes aureus and the cholera spirillum - are destroyed by the process. Sporing forms - viz., the bacillus anthracis, the penicillium glaucum, the bacillus subtilis, and the bacillus mycoides - are not destroyed by the process although reduced in numbers, the inference being that the vegetative forms are destroyed but the spores are not destroyed.

"Buddeised" milk will keep perfectly sweet and apparently unaltered in odour, taste, and appearance for at least from eight to ten days in hot weather and for a still longer period in cold weather.

The/

The Budde process has been adopted extensively by creameries or co-operative dairies in Denmark and Sweden. It is distributed to the consumer in closed bottles instead of in open vessels. Hewlett states that the process appears to have a great future before it for infant, child and invalid feeding and in the treatment of gastro-intestinal disorders.

Four conditions would much tend to mitigate the evil and do away with the necessity for preservatives. These are (1) strict sanitary measures in dealing with the milk at the dairy - i.e., in the milking etc.; (2) the immediate chilling of all milk after milking; (3) the provision of refrigerator vans for transit; and (4) the vending of milk in closed bottles.

The Crèche - a home without parents.

Complicated as the problem of excessive infantile mortality may be, there are nevertheless, obvious remedies that could be applied forthwith by any well-governed community. For instance there is the municipal crèche, or day nursery for the tending of infants whose mothers are working away from home through the day. The good effected by this simple means is incalculable, and the organisation may be made practically self-supporting. Lately a municipal crèche has been adopted at Hammersmith, a suburb of London that possesses/

possesses a large poor population. In Hammersmith alone, 1,800 women are employed in factories, 600 in incandescent mantle making, 1,000 in laundries and 200 in sweetmaking. The appalling infantile mortality of that place has caused considerable heart-searching in the town-council.

Infants' milk depôts.

Another great weapon at hand is the provision of pure milk by a municipal milk supply - infants' milk depôts. The feasibility of such a system has been proved in many towns both at home and abroad. It means the substitution, at a cheap rate, of pure good milk in place of an adulterated, and often contaminated, unwholesome article. To secure a plentiful supply of pure milk for municipal babes is to strike at the root of things, and to lay the foundation of sound bone, brain and muscle for the next generation.

Recently, admirable monographs on the subject have been issued by Dr. G. F. McCleary, M. O. H. for Hampstead, Mr. Lawson Dodd, and others. The movement to establish milk-depots in this country only dates from 1899, when the first of these establishments was opened at St. Helens in Lancashire. These milk-depots are of French origin. In France there are

two different classes of institutions, the one the "consultation de nourrissons", - at which the feeding of infants from the time of birth until about the ninth month is supervised by the Maternity hospitals, whose officials see that breast-feeding is used as far as possible - the other the "goutte de lait" which deals chiefly with hand-fed children in connection with dispensaries, and distributes milk for infant-feeding under expert medical guidance. In 1892 Professor Budin founded the first consultation de nourrissons at the Charite Hospital in Paris. The same year Dr. Variot opened another in connection with the Belleville Dispensary, Paris. The first of the so-called "gouttes de lait" was established at Fecamp in 1894 by Dr. Leon Dafour. There are now upwards of 90 of these establishments in France. Strauss originated a similar movement in New York in 1893, and other countries are following suit. In England depôts have been opened at Liverpool in 1901, Battersea in 1902 and in some half-a-dozen other places, the chief ones being maintained by municipalities. But, as might be imagined, the methods adopted vary considerably.

One of the most interesting of the English experiments/

experiments has been carried on in the Borough of Finsbury. On the first year's working Dr. George Newman has just issued a report. The work has been conducted by a voluntary committee of medical men, assisted by some lady visitors. The principles laid down were - (1) absolute control of the milk, and the avoidance of the serious fallacy of sterilising unclean milk; (2) medical supervision of the entire management of the depot and of the infants using the milk; (3) a discriminating and careful distribution of the milk only to infants who could not be breast-fed; and (4) the systematic study of the effect of the milk on the children. The Finsbury depôt repeats more closely the French model of Goutte de Lait than any other English establishment. It has been managed by a voluntary society (Finsbury Social Workers' Union), which has endeavoured to make the method as individual as possible, and avoid any diminution of the responsibility of the mother.

With regard to what has been written as to the necessity of sterilising milk, Dr. Newman says, "it cannot be too clearly understood that sterilisation does not make bad milk good or dirty milk clean. Nor is it sufficient merely to contract for a supply to the depot from some dairyman of good standing. As/

As far as possible, complete control from the very beginning is necessary to ensure purity." This is sound common sense, and to all who neglect this primary step the section in this suggestive Report dealing with "The preparation of the milk" is to be commended. Dairy farmers and depot enthusiasts must understand "that treatment of the milk, whatever it may be, immediately after its yield and before the contained micro-organisms have had time to multiply or to secrete their products," lies at the basis of all milk reform.

The Finsbury experiment shows that infants' milk depôts may substantially reduce the infant death rates. When properly conducted they may also afford valuable training in infant management. Of course there are economical and other objections to the municipal milk depôt system, but to discuss them would be beside the mark.

Other remedies that have been suggested to secure the proper feeding of infants are: printed instructions as to the rearing of infants should be given to every mother when her child's birth is registered; a band of trained women should be organised who would exercise some degree of home guidance amongst the homes of the poorer/

poorer classes; and, educational authorities should give to girls at school some instruction in the elementary principles of diet and hygiene.

A Model Institution for Infants.

The most advanced scheme for the care of infants is the "infants' home" to be erected at Charlottenburg, a suburb of Berlin. This model institution will include several departments. In the first department pregnant women will be received three months previously to their confinement and after it they will stay there for a fortnight. The children must be fed by the mother and they are therefore transferred to another department termed the "mothers' home", where they stay for three months. For children who have to be fed artificially on account of their mothers being unable to suckle them a third department will be provided, where, moreover, children born outside the institution are to be received. A fourth department is destined for sick infants. In connection with the institution there will be a large dispensary (Fürsorgestelle), which will undertake the after-care of mothers and pregnant women may obtain advice and will be provided with food. Large chemical and bacteriological laboratories and a model cow-house are/

are to be erected, and in addition to the medical and nursing staff a training school for special nurses for children will be attached to the institution.

What more can the practical workers in preventive medicine do than this? Besides dealing with the factor of improper feeding, they have not excluded other factors which are perhaps equally important, such for instance as the adverse conditions affecting the child during its ante-natal existence.

In summing up this study of the artificial feeding of infants it may not be out of place to advance the following conclusions:-

I. The first essential is a supply of good, pure milk. This is, it may be, a matter to a certain extent for legislative control in primis. In cities, at any rate, where poverty is rife, it is essential to have either official, or professional supervision, both of the milk supply and also of the manner and means of its administration, through individual influence with the mothers. So much is a matter of public health, of sociological ideal.

II. In health, the baby can take milk. What is necessary is that the medical man shall thoroughly understand/

understand the principles upon which the preparation of milk to make it suitable to the age, condition, and idiosyncrasies of babies, is conducted; and that he must have patience to teach the mothers how to employ the necessary methods, and persistence in seeing that his instructions are carried out.

III. In disease or disorder, the feeding of the infant is a different and difficult matter, demanding a wide knowledge of possibilities, prompt action as a sequel to shrewd decision, and unwearying attention.